United States Patent Office Utility Patent Application

Blood Pressure Simulation Apparatus with Tactile Interface

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October 2, 2003

BACKGROUND FOR THE INVENTION

Field of Invention

This invention relates to a human blood pressure simulation apparatus that provides the user tactile sensations representing the level of pressure within his or her cardio-vascular system during the cardiac cycle of pumping blood throughout the body. Both systolic and diastolic blood pressure levels are simulated at the pulse rate of the simulated cardiac output. The user may compare, by physical feel, his or her blood pressure cycle simulation with that of a normal blood pressure level simulation.

Background

Hypertension (high blood pressure) has been called “the silent killer” by health professionals since it damages the human body without being felt by the victim. It is well known that abnormal blood pressure levels can lead to many health related problems and even death. Many millions of people each year have their blood pressure measured, however, only very few actually know what the numbers mean physically with regards to the pressures experienced by their blood vessels and heart. Even less have a sense of what force is exerted by the heart on their blood vessels by normal and abnormal blood pressure levels. To increase the awareness of blood pressure levels in humans, an apparatus has been invented, as described herein, to provide physically sensible feedback in relation to the blood pressure cycle.

SUMMARY OF THE INVENTION

This invention provides tactile indications to human subjects related to blood pressure forces experienced by cardio-vascular systems under normal and abnormal human blood pressure cycles. The instant invention permits human subjects to physically feel the cyclic pressure experienced by their heart or blood vessels by providing simulation of blood pressure cycles and by including a physical interface by which the subject can sense the force on his or her heart or blood vessels at both the systolic and diastolic portions of the simulated cardiac cycle.

Current medical literature cites normal blood pressure amplitudes for humans to be near 120mm of Hg for the systolic phase and 80mm of Hg for the diastolic phase relative to the atmospheric pressure. The units of "mm of Hg" refer to a mercury column (vertical manometer) supported by the blood pressure as measured by blood pressure measuring equipment such as a sphygmomanometer. The height of a vertical column of liquid is an accepted unit of pressure in scientific and medical literature. However, it is anticipated that very few people know what magnitudes of 120 mm of Hg, 80 mm of Hg, etc., actually mean in regard to pressure levels. To further complicate the issue, much of the time, the units on these pressure values are dropped for brevity and are simply reported as unitless numbers as "120/80" as the systolic pressure over the diastolic pressure.

Blood pressure is such a vital health parameter that it is extremely important that people have an accurate physical feeling for what their blood pressure level means relative to normal blood pressure. While customary reporting of systolic pressures over diastolic pressures is one way of relative abstract comparison with normal blood pressure levels, the experience of physically feeling what normal and abnormal blood pressure cycles are like is quite dramatic and has much more lasting impact on the subject. A subject actually feeling his or her abnormal blood pressure level through the apparatus of the instant invention may be more likely to comply with prescribed therapies such as taking medications, engaging in physical exercise, dieting, reduction of body mass, etc. in order to achieve normal blood pressure levels. It is well known that humans cannot feel the level of their arterial blood pressure by pressing their fingers against their veins or arteries near the surface of their skin.

In accordance with the invention, a sense of physical feel as a pressure magnitude comparison is provided rather than an abstract mental comparison of numerical values representing blood pressure levels. A pressurized fluid containing vessel with an interface which permits human subjects to receive tactile sensations of the pressure levels representing those experienced within the subject's blood vessels or heart is provided. It is understood that the use of the term "fluid" herein includes a gas or a liquid or both.

Various embodiments are described herein to simulate the parameters of the human blood pressure cycle and to convey those parameters to human subjects through the sense of touch.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig.1 is a block diagram of the electronic controlled embodiment of the Blood Pressure Simulation Apparatus with Tactile Interface.

Fig.2 is a drawing of the manually controlled embodiment of the Blood Pressure Simulation Apparatus with Tactile Interface.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

One preferred embodiment of the Blood Pressure Simulation Apparatus with Tactile Interface is shown in Figure 1. A pressurized fluid generator **100** provides a fluid above the ambient pressure to serve as the working medium within the pressure vessel with moveable surface providing tactile interface **120**. The fluid is air in one embodiment. In another embodiment of the invention, the fluid is an incompressible liquid segregated from a gas to provide pressurization. The pressurized fluid generator **100** is an electric powered pump in one embodiment, a compressed fluid storage vessel in another embodiment, and a manually operated pump in yet another embodiment. A fluid pressure control element **110** serves as a pressure regulator to control the pressure level within the pressure vessel with moveable surface **120.** A fluid pressure sensor **130** senses the pressure level within the pressure vessel with moveable surface **120** and provides pressure data feedback to the electronic control unit **140**. A manifold **135** pneumatically connects the fluid pressure control element **110,** the pressure vessel with moveable surface **120,** and the fluid pressure sensor **130.** A power supply **150** provides electrical energy to the electronic control unit **140**. User-operated controls to define pressure excursion parameters **160** provide the user a preferred method to set the simulated diastolic blood pressure and systolic blood pressure levels within the pressure vessel with moveable surface **120** and to set the simulated cardiac pulse rate where, in one embodiment, these controls include electronic switches or variable resistors. In one embodiment, an optional data interface to an electronic sphygmomanometer **170** automatically transfers the human subject blood pressure data as input settings to the electronic control unit **140** to maintain the simulated diastolic and systolic blood pressure levels and the periodicity of the simulated cardiac cycle within the pressure vessel with moveable surface **120** to be equivalent to the respective pressure levels and cardiac cycle periodicity as measured from the subject by the electronic sphygmomanometer (not shown). An optional data display **180** is used in one embodiment to indicate to the user the simulated diastolic and systolic blood pressure levels. The electronic control unit **140** is the master controller unit of the apparatus interfacing with the fluid pressure sensor **130**, the fluid pressure control element **110**, the user operated controls **160**, an optional data interface to the electronic sphygmomanometer **170**, and the optional data display **180**. The electronic control unit **140** electronically maintains the periodicity and pressure levels within the pressure vessel with moveable surface **120** for the simulated blood pressure cycles. In one embodiment, the electronic control unit **140** circuitry includes a microprocessor.

The pressure vessel with moveable surface **120** is the tactile interface with human subjects to physically communicate the pressure induced forces acting on blood vessels or heart subjected to blood pressure levels. The pressure level inside the pressure vessel with moveable surface **120** is communicated to a human subject through touching of at least one moveable surface. In one embodiment the pressure vessel with moveable surface **120** is comprised of a rubber or elastomeric hollow bulb (similar to the bulb **220** shown in Figure 2) designed to be squeezed in one hand while a simulated blood pressure is applied to the bulb. In this embodiment, the user feels the force experienced by the walls of blood vessels or the heart under pressure and gets a true sense of the containment force required to maintain the blood vessels intact or the force the heart exerts to pump blood. In one embodiment, a small volume bulb can communicate the force exerted on the blood vessels while a larger volume bulb can communicate the force exerted by the heart. The forces due to abnormal blood pressure levels can be compared relative to forces due to normal blood pressure levels by adjusting the user-operated controls **160.** In another embodiment, the rubber or elastomeric hollow bulb has a rigid, incompressible solid member positioned inside so that the human subject can compress the bulb by hand so at least some portion of the inner bulb surface remains in contact with the solid member, thus providing consistent feel and reduced tendency for the subject to randomly squeeze the bulb during blood pressure simulation. The incompressible member may further include at least one electrical contact to sense when the bulb has been squeezed to contact the incompressible member. In another embodiment, the pressure vessel with moveable surface **120** is comprised of a piston cylinder apparatus (not shown) whereby a human subject can feel the force on the piston induced by the simulated blood pressure levels. In yet another embodiment, an inflatable cuff serves as the tactile interface whereby a human body appendage such as a finger, hand, arm, or leg is surrounded by the cuff. In still yet another embodiment, an elastic walled, closed ended tube to simulate a blood vessel section serves as the tactile interface whereby a person can grip the tube to feel the force on the tube wall as an indication of the force exerted on a blood vessel wall due to a blood pressure cycle. All embodiments of the invention provide the user of the apparatus a physical feeling for the level of simulated blood pressure within the pressure vessel with moveable surface **120.** The apparatus may simulate normal as well as abnormal human blood pressure levels.

In another preferred embodiment, the apparatus of Figure 1 is integrally combined with an electronic sphygmomanometer to comprise a single unit capable of reading blood pressure levels and simulating the diastolic and systolic blood pressure levels so the human subject can physically feel the pressure induced forces experienced by the subject's own blood vessels.

Another preferred embodiment of the Blood Pressure Simulation Apparatus with Tactile Interface is shown in Figure 2. The large volume elastomeric hollow bulb **200,** the pressure indicator **210,** the small volume elastomeric hollow bulb **220,** and the connecting tubing **230** form a closed system. The terms "large" and "small" as used herein are relative terms only, and it is understood that the large volume elastomeric hollow bulb **200** contains as least as much volume as the small volume elastomeric hollow bulb **220**. Both the large volume elastomeric hollow bulb **200** and the small elastomeric hollow bulb **220** may be held and compressed, at least partially, in a human hand. The user experiencing the blood pressure cycle simulation holds the small elastomeric hollow bulb **220** in one hand and squeezes the bulb to reduce the volume and to increase the fluid pressure indicated on the pressure indicator **210** to a level below the desired simulated diastolic blood pressure. In one embodiment as shown in Figure 2, an incompressible member **240** is located within the small elastomeric hollow bulb **220** such that the user squeezes the bulb **220** so that the interior walls of the bulb **220** make contact with the incompressible member **240.** A fluid bleed valve **250** is manually operated to reduce the mass of fluid in the closed system so the pressure as indicated by the pressure indicator **210** can be set below the desired simulated diastolic blood pressure. The user then alternately squeezes and partially releases the large elastomeric hollow bulb **200** with the other hand to simulate and manually control the diastolic and systolic blood pressure levels desired within the small elastomeric hollow bulb **220** as indicated on the pressure indicator **210.** The user's hand continuing to grasp the small elastomeric hollow bulb **220** experiences force sensations indicative of the forces experienced by human blood vessel walls undergoing blood pressure cycles. Alternatively, a person other than the one experiencing the blood pressure simulation operates the large volume elastomeric hollow bulb **200** to drive and control the simulated blood pressure cycles. In one embodiment, the pressure indicator **210** is an electronic pressure sensor with digital display of pressure level. In another embodiment, the pressure indicator **210** is an analog pressure gage. In yet another embodiment, the pressure indicator **210** is a manometer.

It is understood that the concepts of the elastomeric hollow bulb described in this specification and appended claims are intended to be broad in scope and include all vessels having at least some non-fixed surface portion that can be used by humans to sense, through touch, pressure levels within such vessels. One function of the vessels with at least some non-fixed surface portion is to provide significant force amplification within the vessel compared to the force exerted on the walls of the relatively small diameter conduits comprising the manifold **135** and tubing **230** connecting the system components. The functions of elastomeric hollow bulbs described within this specification and appended claims may also be replaced with a bellows apparatus without loss of intended function of the invention.

The various preferred embodiments described above are merely descriptive of the present invention and are in no way intended to limit the scope of the invention. Modifications of the present invention will become obvious to those skilled in the art in light of the detailed description above, and such modifications are intended to fall within the scope of the appended claims.